

What is claimed is:

- 1 1. A glass molding die, comprising:
2 a substrate;
3 a first noble metal layer overlying the substrate;
4 a second noble metal layer overlying the first noble
5 metal layer;
6 a carbon-containing third noble metal layer overlying
7 the second noble metal layer; and
8 a DLC (diamond-like carbon) passivation film overlying
9 the third noble metal layer.
- 1 2. The molding die as claimed in claim 1, wherein the
2 substrate comprises tungsten carbide.
- 1 3. The molding die as claimed in claim 1, wherein the
2 first noble metal layer comprises Ni-containing Ir-Re alloy.
- 1 4. The molding die as claimed in claim 1, wherein the
2 thickness of first noble metal layer comprises about 0.3 to
3 0.6 μ m.
- 1 5. The molding die as claimed in claim 1, wherein the
2 second noble metal layer comprises Ir-Re alloy.
- 1 6. The molding die as claimed in claim 1, wherein the
2 thickness of second noble metal layer is about 0.3 to 0.6 μ m.
- 1 7. The molding die as claimed in claim 1, wherein the
2 thickness of third intermediate layer is about 0.01 to
3 0.05 μ m.

1 8. The molding die as claimed in claim 1, wherein the
2 third noble metal layer comprises carbon-containing Ir-Re
3 alloy with C, Ir, and Re atoms therein approximately
4 arranged in superlattice.

1 9. The molding die as claimed in claim 8, wherein
2 carbon concentration in the third noble metal layer is
3 approximately 20% or more.

1 10. The molding die as claimed in claim 1, wherein the
2 third noble metal layer comprises carburized Ir-Re alloy.

1 11. The molding die as claimed in claim 10, wherein
2 carbon concentration in the carburized surface of the third
3 noble metal layer is approximately 20% or more.

1 12. The molding die as claimed in claim 1, wherein the
2 thickness of passivation film is about 0.01 to 0.3 μ m.

1 13. The molding die as claimed in claim 1, wherein the
2 passivation film comprises a molding surface.

1 14. The molding die as claimed in claim 1, wherein
2 when the DLC passivation film deteriorates, the deteriorated
3 DLC passivation film and third noble metal layer are removed
4 by oxygen plasma, followed by sequential formation of the
5 third noble layer and DLC passivation film overlying the
6 second noble metal layer.

1 15. A renewing method for a glass molding die,
2 comprising:

3 providing a used glass molding die comprising a
4 substrate, a first noble metal layer overlying
5 the substrate, a second noble metal layer
6 overlying the first noble layer metal, a carbon-
7 containing third noble metal layer overlying the
8 second noble metal layer, and a DLC passivation
9 film overlying the third noble metal layer;
10 removing the passivation film and third noble metal
11 layer using oxygen plasma;
12 grinding and polishing the molding die to completely
13 remove the third noble metal layer;
14 cleaning the polished molding die;
15 forming a fourth noble metal layer overlying the second
16 noble metal layer; and
17 forming a second passivation film comprising
18 approximately the same material as the
19 passivation film overlying the fourth noble metal
20 layer.

1 16. The method as claimed in claim 15, wherein the
2 substrate comprises tungsten carbide.

1 17. The method as claimed in claim 1, wherein the
2 first noble metal layer comprises Ni-containing Ir-Re alloy.

1 18. The method as claimed in claim 15, wherein the
2 thickness of first noble metal layer comprises about 0.3 to
3 0.6 μ m.

1 19. The method as claimed in claim 15, wherein the
2 second noble metal layer comprises Ir-Re alloy.

1 20. The method as claimed in claim 15, wherein the
2 thickness of second noble metal layer is about 0.3 to 0.6 μ m.

1 21. The method as claimed in claim 1, wherein the
2 thickness of third intermediate layer is about 0.01 to
3 0.05 μ m.

1 22. The method as claimed in claim 15, wherein the
2 third noble metal layer comprises carbon-containing Ir-Re
3 alloy with C, Ir, and Re atoms therein approximately
4 arranged as superlattice.

1 23. The method as claimed in claim 15, wherein the
2 third noble metal layer comprises carburized Ir-Re alloy.

1 24. The method as claimed in claim 15, wherein the
2 fourth noble metal layer comprises approximately the same
3 material as the third noble metal layer.

1 25. The method as claimed in claim 15, wherein the
2 fourth noble metal layer comprises carbon-containing Ir-Re
3 alloy with C, Ir, and Re atoms therein approximately
4 arranged as superlattice.

1 26. The method as claimed in claim 25, further
2 comprising forming the fourth noble metal layer using co-
3 sputtering with multiple targets.

1 27. The method as claimed in claim 25, wherein carbon
2 concentration in the fourth noble metal layer is
3 approximately 20% or more.

1 28. The method as claimed in claim 15, wherein the
2 fourth noble metal layer comprises carburized Ir-Re alloy.

1 29. The method as claimed in claim 28, wherein forming
2 the fourth noble metal layer further comprises:

3 forming a Ir-Re alloy layer overlying the second noble
4 metal layer; and

5 implanting carbon ions into a surface of the Ir-Re
6 alloy layer, thereby carburizing the Ir-Re alloy
7 layer.

1 30. The method as claimed in claim 28, wherein carbon
2 concentration in the carburized surface of the fourth noble
3 metal layer is approximately 20% or more.

1 31. The method as claimed in claim 15, wherein the
2 thickness of second passivation film is about 0.01 to 0.3 μ m.

1 32. The method as claimed in claim 1, wherein the
2 second passivation film has a molding surface.